

CLAIMS

1. A method for producing a magnetic resonance image of a patient using a magnetic resonance imaging (MRI) system, the steps comprising:
 - a) injecting the patient with a contrast agent which flows into a region of interest in the patient;
 - 5 b) acquiring NMR k-space data for a series of NMR time course images during a time resolved phase of an examination, during which the contrast agent makes a first passage through the patient's arteries in the region of interest;
 - c) reconstruct a series of corresponding low resolution time course images using a central portion of the NMR k-space data acquired in step b);
 - 10 d) producing an orthogonality image by measuring the degree to which voxel vectors formed from data in corresponding voxels in the series of low resolution time course images are orthogonal to a model time course voxel vector;
 - e) producing a mask image by determining which voxels in the orthogonality image exceed a threshold;
 - 15 f) producing a series of low resolution vascular images by multiplying the low resolution time course images by the mask;
 - g) transforming the series of low resolution vascular images to produce a corresponding series of filtered k-space center data sets;
 - h) combining a peripheral portion of the NMR k-space data acquired in step b)
 - 20 with the corresponding series of filtered k-space center data sets to form a series of filtered k-space data sets; and
 - i) reconstructing an image by transforming a filtered k-space data set.
2. The method as recited in claim 1 in which a series of images are reconstructed in step i) by transforming the corresponding series of the filtered k-space data sets.

3. The method as recited in claim 1 in which the model time course voxel vector is produced with a method which comprises:

j) producing a matrix $[A]$ having values which model the characteristic behavior of NMR signals produced by undesirable tissues during the performance of step b); and step
5 d) includes calculating the orthogonal complement of the matrix $[A]^\perp$.

4. The method as recited in claim 3 in which the orthogonality image is produced in step d) by the equation

$$[A]^\perp * \vec{x} = \vec{b}$$

where \vec{b} = is a voxel vector; and

5 \vec{x} = is a value in the orthogonality image at the corresponding voxel location.

5. The method as recited in claim 1 in which the threshold is produced with a method which comprises:

l) producing a histogram using values related to values from the orthogonality image; and
5 m) examining the histogram to establish a threshold which distinguishes vascular voxels from other voxels.

6. The method as recited in claim 5 in which step l) includes calculating the natural logarithm of the orthogonality image values.

7. The method as recited in claim 1 which further includes:
 - n) producing an inverted mask image;
 - o) producing a series of low resolution background images by multiplying the low resolution time course images by the inverted mask;
- 5 p) weighting the low resolution background images to suppress the values therein; and
 - q) combining the low resolution background images with the corresponding low resolution vascular images.
8. The method as recited in claim 7 in which step p) is performed using values from the orthogonality image.
9. The method as recited in claim 1 in which step b) is performed using a 3D projection reconstruction pulse sequence.

10. A method for producing a magnetic resonance image of a patient using a magnetic resonance imaging (MRI) system, the steps comprising:

- a) injecting the patient with a contrast agent which flows into a region of interest in the patient;
- 5 b) acquiring NMR k-space data for a series of NMR time course images during a time resolved phase of an examination, during which the contrast agent makes a first passage through the patient's arteries in the region of interest;
- c) reconstruct a series of corresponding low resolution time course images using a central portion of the NMR k-space data acquired in step b);
- 10 d) producing a model time course voxel vector which is indicative of NMR signals produced by undesired tissues;
- e) suppressing the signals in voxels of the low resolution time course images which have time course voxel vectors that do not differ significantly from the model time course voxel vector;
- 15 f) transforming the series of low resolution images to produce a corresponding series of filtered k-space center data sets;
- g) combining a peripheral portion of the NMR k-space data acquired in step b) with the corresponding series of filtered k-space center data sets to form a series of filtered k-space data sets; and
- 20 h) reconstructing an image by transforming a filtered k-space data set.

11. The method as recited in claim 10 in which the model time course voxel vector is a matrix $[A]$ having values which model the characteristic behavior of a plurality of NMR signals produced by undesirable tissues and the difference between the model time course voxel vector and time course voxel vectors is measured using the orthogonal 5 complement $[A^\perp]$ of the matrix $[A]$.

12. The method as recited in claim 10 in which the model time course voxel vector models the behavior of NMR signals having a substantially constant value during the performance of step b).

13. The method as recited in claim 10 in which the model time course voxel vector models the behavior of NMR signals that ramp up in value during the performance of step b).

14. The method as recited in claim 12 in which the model time course voxel vector also models the behavior of NMR signals that ramp up in value during the performance of step b).